

Beam Profile Influence on Polymerization Characteristics of Resin-Matrix Composites

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The objective of this study was to quantify the homogeneity of the beam of light radiated from each of two different light-curing units (LCUs) using beam profiling, and then evaluate the relationship between these beam profiles and polymerization patterns of a resin-matrix composite (RMC). Beam profile and irradiance measurements of one light-emitting diode (LED) and one quartz-tungsten-halogen (QTH) curing unit were collected using a beam-profiler-system and a MARC-RC resin calibrator, respectively. The camera-based beam-profiler-system (BGP-USB-SP620 with 50-mm-lens, Ophir-Spiricon) combined radiant-power-values from an irradiance-probe (cosine-corrector/spectrometer-assembly) to measure beam-homogeneity (the distribution of irradiance-values across the light-beam) for each curing-unit. A mapping approach was used to investigate the polymerization pattern of nano-hybrid RMC samples (5×5×2mm) at various depths utilizing both micro-Raman-spectroscopy (degree-of-conversion, DC) and ethanol softening (cross-link-density, CLD), which was determined using automated-microhardness testing after exposure to ethanol. Two-sample t-tests with unequal-variances were used to compare the LCUs for differences in irradiance (mW/cm^2) and radiant-exposure (J/cm^2). Comparisons among polymerization by depths with-respect-to LCU were made using paired t-tests and two-sample t-tests as appropriate for the specific depths. The effects at each depth of location on the sample and LCU were tested using mixed-model ANOVA. The LED demonstrated inhomogeneity and significantly higher irradiance values compared to the QTH. Both LCUs demonstrated variations in DC (62-74%) and percent Knoop hardness number (KHN) reduction (33-49%) at different depths and locations. A gradual decrease in KHN occurred from top to bottom in the RMC cured with QTH unlike the LED. A gradual decrease in CLD was exhibited in both LCUs. This study showed that the beam-profile-inhomogeneity of QTH and LED curing-units resulted in localized differences in DC, KHN and CLD of RMC samples at specific depths and locations. However, adequate polymerization of the RMC was achieved at all points when using the LED LCU.